C H A P T E R ③

Tuning & Specifications

Chapter Objectives

The information in this chapter will enable you to:

- Tune your drive to your motor, and operate your system at maximum efficiency.
- Use the information to compare system performance with different motor, power, and wiring configurations (speed/torque curves).

Short-Circuit Protection

The OEM750/OEM705X is protected against phase-to-phase and phase-to-ground short circuits. Never short circuit the motor leads for motor braking.

Low Speed Resonance

Resonance exists in all step motors and is a function of the motor's mechanical construction. It can cause the motor to stall at low speeds. Most full step motor controllers jump the motor to a set minimum starting speed that is greater than the resonance region. The OEM750/OEM705X's micro-stepping capability allows you to operate a motor smoothly at all speeds.

Motors that will not accelerate past 1 rps may be stalling due to resonance. You can add inertia to the motor shaft by putting a drill chuck on the shaft. The drill chuck may provide enough inertia to test the motor when it is not connected to the intended load.

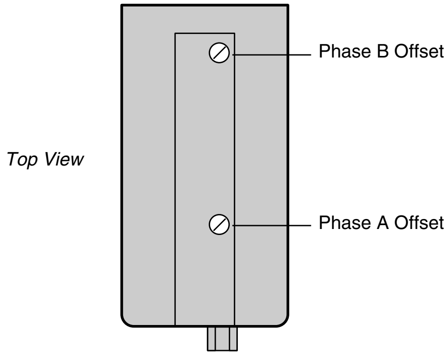
Mid-Range Instability

All step motors are subject to mid-range instability. This instability, or oscillation, may stall the motor at speeds from 6 to 16 rps. The OEM750/OEM750X includes active circuitry to help suppress these oscillations. This feature is normally enabled, but may be disabled by DIP SW2-#1 (see *DIP Switch Functions* in *Chapter 2*) if it has an adverse effect on your system.

Tuning Procedure

Tuning on the OEM750/750X consist of two different aspects. The first is a current loop gain adjustment designed to match the drive's current compensation gain to the motor's inductance and the motor supply voltage. This was described in *Chapter 2, Installation*, in *DIP Switch Functions*. The second is an amplifier adjustment designed to match the amplifier offsets to your specific motor.

You can tune your OEM750/OEM750X to your specific motor. In the procedure below, you will minimize resonance and optimize smoothness by adjusting the small potentiometers on the top of the unit. The next figure shows the location of the potentiometers and their functions.



Tuning Potentiometers

- Phase A Offset: Adjusts DC offset of the phase current for Phase A
- Phase B Offset: Adjusts DC offset of the phase current for Phase B

Since tuning is affected by operating current, you may have to adjust these potentiometers during the configuration or installation process. For best results, the drive and motor should be on, connected to the load, and warmed up for 30 minutes prior to tuning.

DETERMINING MOTOR RESONANCE

There are several methods you can use to determine the level of motor resonance in your system.

Tachometer Method

Use an oscilloscope to gauge the output of a tachometer attached to the motor shaft. The tachometer will output a DC voltage, proportional to speed. This voltage will oscillate around an average voltage when the motor is resonating. The amplitude of this oscillation will be at its maximum when you run the motor at its *resonance speed*. The goal of this method is to adjust the system for the lowest oscillation amplitude.

Sounding Board Method

You can practice your tuning skills with an unloaded motor placed on a sounding board or table. When you command a velocity that is near the motor's *resonance speed*, the phenomenon will cause an audible vibration. The goal of this method is to adjust the system for the least amount of vibration.

Stethoscope Method

When you tune your motor under loaded conditions, you can hear the audible vibration caused by the motor's natural frequency by placing the tip of a screw driver against the motor casing and placing the handle of the screw driver close to your ear (as you would a stethoscope). You will also be able to hear the different magnitudes of vibration caused by the motor's natural frequency. The goal of this method is to adjust the system for the least amount of vibration.

Touch Method

After you have had some experience with tuning, you should be able to locate the motor's *resonance speed* by placing your fingertips on the motor shaft and adjusting the motor's velocity. Once the resonance speed is located, you can adjust the system for maximum smoothness.

TUNING THE DRIVE TO THE MOTOR

To tune your drive to your motor, follow these directions:

1. Command the drive (via RS-232C or STEP & DIRECTION inputs) so that the motor is running at maximum roughness, as shown below for the 1st speed motor resonance.

		1st Speed	2nd Speed
Size 23		**Resonance**	**Resonance**
OS2HA	(OEM57-40)	1.8 rps	3.6 rps
OS21A	(OEM57-51)	1.8 rps	3.6 rps
OS22A	(OEM57-83)	1.8 rps	3.6 rps
Size 34			
RS31B	(OEM83-62)	1.4 rps	2.8 rps
RS32B	(OEM83-93)	1.4 rps	2.8 rps
RS33B	(OEM83-135)	1.4 rps	2.8 rps

2. Adjust Offsets A and B for best smoothness.
3. Double the motor speed (2nd speed resonance) until the motor runs roughly again.
4. Adjust offsets A and B again for best smoothness.
5. Repeat above steps until no further improvement is noted.

ADJUSTING MOTOR CURRENT WAVEFORMS

Step motor manufacturers make every effort to design step motors that work well with sinusoidal current waveforms. However, due to physical limitations, most motors operate best with a current waveform other than a pure sine wave.

The purpose of adjusting motor current waveforms is to cause the step motor to move with equal step sizes as the current waveforms are sequenced through the motor. This waveform adjustment will also help the motor run more smoothly. You can change the waveform with DIP SW2-#6 – SW2-#8

Motor waveforms are usually adjusted after the drive has been tuned to its motor. If you do not have precision measurement equipment, you may select the correct motor waveform with one of the methods described previously in this chapter (Tachometer Method, Sounding Board Method, Stethoscope Method, and Touch Method). These empirical methods generally yield acceptable results.

Performance Specifications

Accuracy	±5.0 arcminutes typical (unloaded, bidirectional) with OS, RS, or OEM Series motors.
Repeatability	±5 arcseconds typical (unloaded, bidirectional).
Hysteresis	Less than 2 arcminutes—0.0334° (unloaded, bidirectional).

Motor Specifications

Speed/torque curves, specifications, and dimensions are shown on the following pages.

MOTOR PART NUMBER – CROSS REFERENCE TABLE

When Compumotor introduced the OEM750/OEM750X, we changed the part numbering system for some existing motors, and introduced several new motors. The next table summarizes the changes and additions. (The letters *"n"* represent variables that can change, based upon the options ordered.)

Motor Size	New Part Number	Old Part Number
Size 23	OS2HA-SNFLY	OEM57-40-MO
	OS21A-SNFLY	OEM57-51-MO
	OS22A-SNFLY	OEM57-83-MO
Double Shaft:	OS2nA-DNFLY	OEM57-nn-MO-DS23
Encoder:	OS2nA-DNFLY-HJ	OEM57-nn-MO-ENC

OS Series motors are the same motors as OEM57– Series Motors; the new part number is the only difference.

	New Motor	Similar to Existing Motor:
Size 34	RS31B–*nnnnn*	OEM83–62–*nn–nnnn*
	RS32B–*nnnnn*	OEM83–93–*nn–nnnn*
	RS33B–*nnnnn*	OEM83–135–*nn–nnnn*

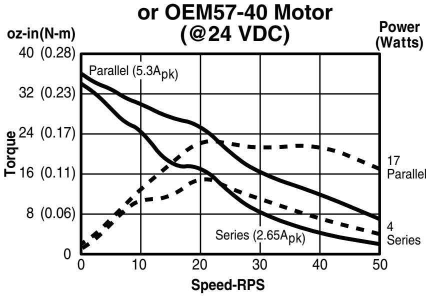
RS Series motors are similar (but not identical) in size and electrical characteristics to OEM83 Series motors. The motors differ in internal construction. Also, RS motors have cables; OEM83 motors have flying leads, and are internally wired in parallel.

Speed/Torque Curves

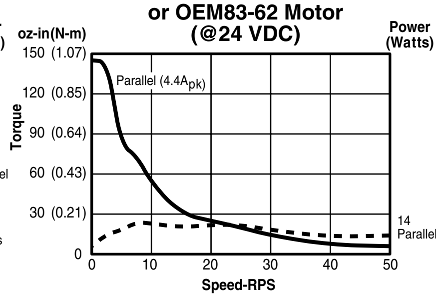
Speed/torque curves are shown below for operation at 24VDC, 48VDC, and 75VDC. Series and parallel curves are shown for 23 frame size motors. Parallel curves only are shown for 34 frame size motors. (OEM83 motors are internally wired in parallel and can only be operated in parallel.)

Power curves are shown as dashed lines.

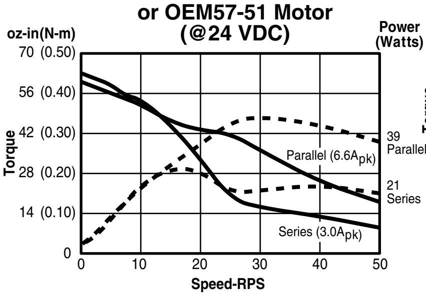
OEM750 with OS2HA or OEM57-40 Motor (@24 VDC)



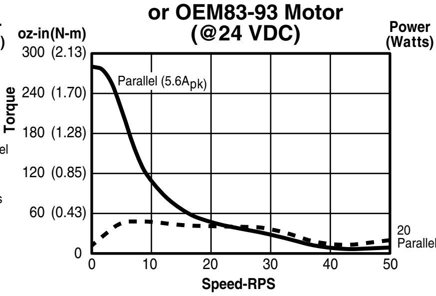
OEM750 with RS31B or OEM83-62 Motor (@24 VDC)



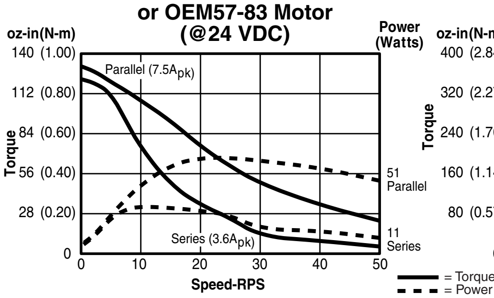
OEM750 with OS21A or OEM57-51 Motor (@24 VDC)



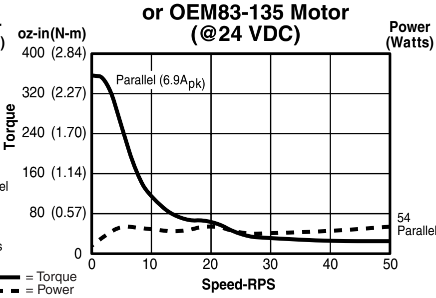
OEM750 with RS32B or OEM83-93 Motor (@24 VDC)



OEM750 with OS22A or OEM57-83 Motor (@24 VDC)



OEM750 with RS33B or OEM83-135 Motor (@24 VDC)



Note 1: Parallel connected motors are limited to 50% duty cycle when operated above 5 rps. For greater then 50% duty cycle above 5 rps, you must connect the motor in series. Fan cooling the motor will increase duty cycles above 5 rps.

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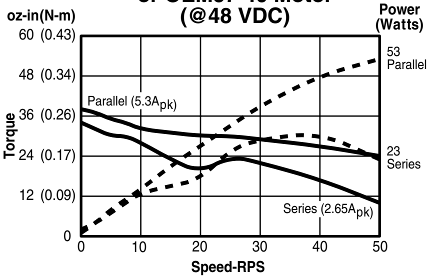
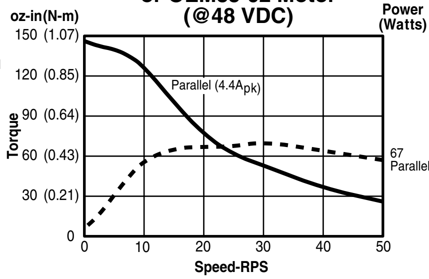
Note 2: +/-10% torque tolerance due to motor tolerance

OEM750/OEM750X Speed/Torque Curves at 24VDC

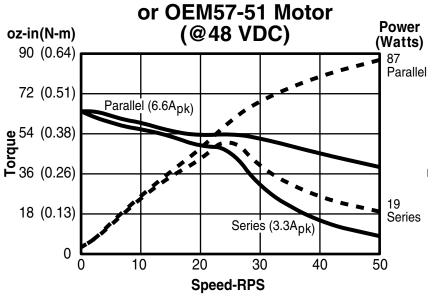
OEM750 with OS2HA or OEM57-40 Motor (@48 VDC)



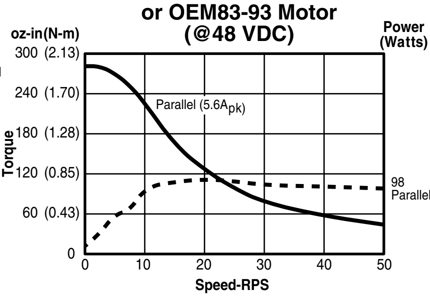
OEM750 with RS31B or OEM83-62 Motor (@48 VDC)



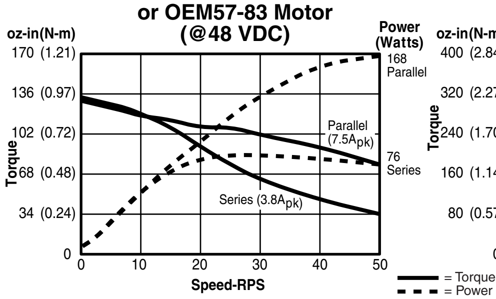
OEM750 with OS21A or OEM57-51 Motor (@48 VDC)



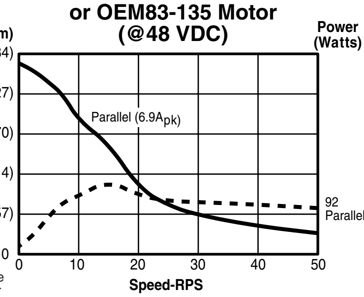
OEM750 with RS32B or OEM83-93 Motor (@48 VDC)



OEM750 with OS22A or OEM57-83 Motor (@48 VDC)



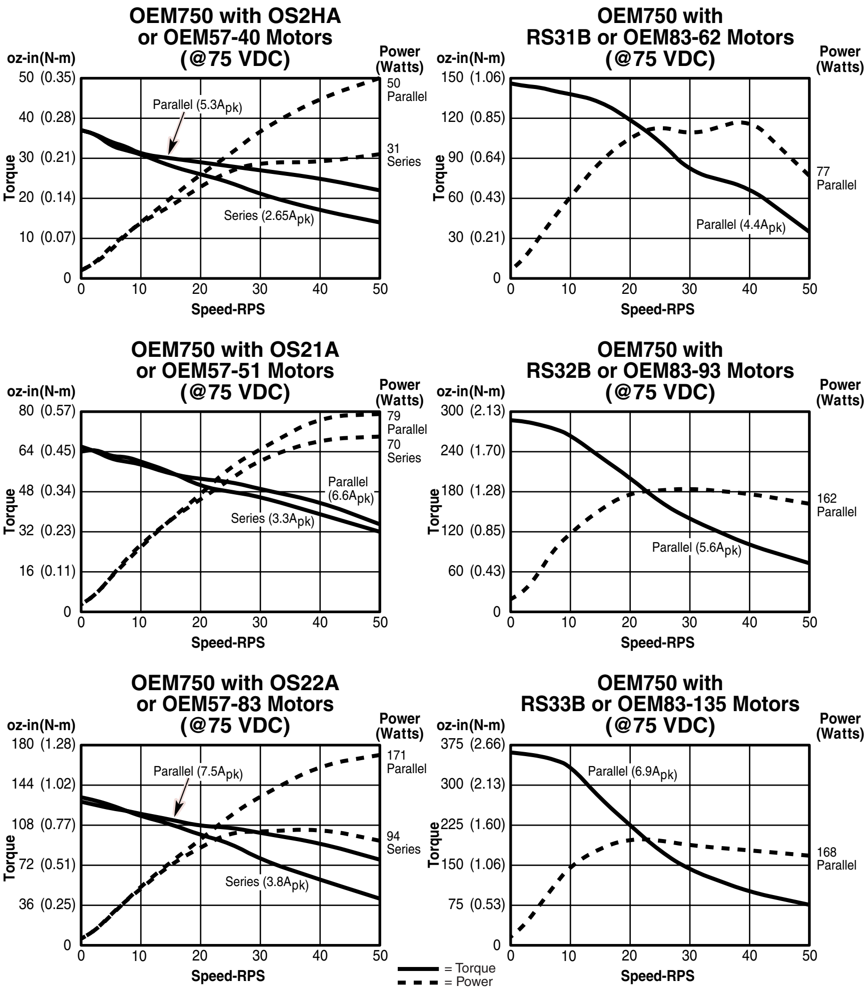
OEM750 with RS33B or OEM83-135 Motor (@48 VDC)



Note 1: Parallel connected motors are limited to 50% duty cycle when operated above 5 rps. For greater then 50% duty cycle above 5 rps, you must connect the motor in series. Fan cooling the motor will increase duty cycles above 5 rps.

Note 2: +/-10% torque tolerance due to motor tolerance.

OEM750/OEM750X Speed/Torque Curves at 48VDC



Note 1: Parallel connected motors are limited to 50% duty cycle when operated above 5 rps. For greater then 50% duty cycle above 5 rps, you must connect the motor in series. Fan cooling the motor will increase duty cycles above 5 rps.

Note 2: +/-10% torque tolerance due to motor tolerance.

OEM750/OEM750X Speed/Torque Curves at 75VDC

Motor Specifications—23 Frame Size

	OS2HA (OEM57-40)	OS21A (OEM57-51)	OS22A (OEM57-83)
Static Torque**			
oz-in	37	66	133
(Nm)	(0.26)	(0.47)	(0.94)
Rotor inertia			
oz-in^2	0.38	0.65	1.39
(kg-cm^2)	(0.07)	(0.12)	(0.25)
Drive current—Series**			
Apk	2.65	3.3	3.8
(Arms)	(1.9)	(2.3)	(2.7)
Drive current—Parallel**			
Apk	5.3	6.6	7.5
(Arms)	(3.7)	(4.7)	(5.3)
Phase inductance (mH)***			
Series	1.7	1.8	2.8
Parallel	0.4	0.4	0.7
Detent Torque			
oz-in	2.5	4.0	7.0
(Nm)	(0.018)	(0.028)	(0.049)
Bearings Information			
Thrust Load			
lb	13	13	13
(kg)	(5.9)	(5.9)	(5.9)
Radial load			
lb	20	20	20
(kg)	(9.1)	(9.1)	(9.1)
End Play *(reversing load equal to 1 lb)*			
in	0.001	0.001	0.001
(mm)	(0.025)	(0.025)	(0.025)
Radial Play *(per 0.5 lb load)*			
in	0.0008	0.0008	0.0008
(mm)	(0.02)	(0.02)	(0.02)
Motor Weight			
lb	1	1.5	2.5
(kg)	(0.45)	(0.68)	(1.14)
Certifications			
UL recognized	Pending	Pending	Pending
CE (LVD)	Yes	Yes	Yes

** Values shown in speed-torque curves at 75VDC

*** Small signal inductance values

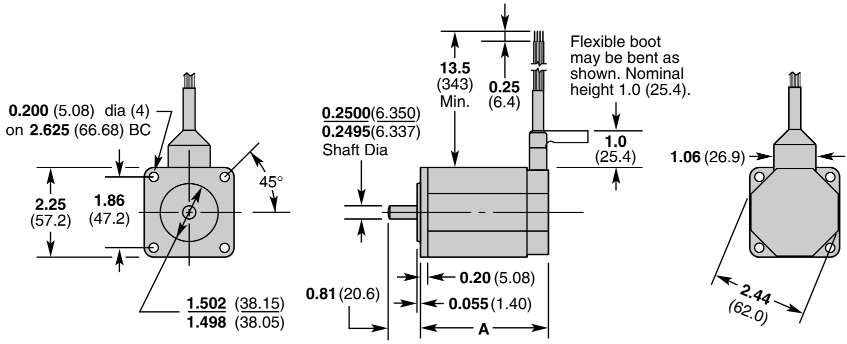
MOTOR SPECIFICATIONS—34 FRAME SIZE

	OEM83-62	OEM83-93	OEM83-135	RS31B	RS32B	RS33B
Static Torque**						
oz-in	160	300	400	146	287	361
(Nm)	(1.14)	(2.14)	(2.80)	(1.03)	(2.02)	(2.55)
Rotor inertia						
$oz\text{-}in^2$	3.47	6.76	10.47	3.204	6.563	9.652
($kg\text{-}cm^2$)	(0.634)	(1.24)	(1.91)	(0.583)	(1.195)	(1.757)
Drive current—Series**						
Apk	n/a	n/a	n/a	n/a	n/a	n/a
(Arms)	n/a	n/a	n/a	n/a	n/a	n/a
Drive current—Parallel**						
Apk	4.4	5.6	6.9	4.4	5.6	6.9
(Arms)	(3.1)	(4.0)	(4.9)	(3.1)	(4.0)	(4.9)
Phase inductance (mH)***						
Series	n/a	n/a	n/a	11.6	11.6	9.6
Parallel	2.2	2.2	2.2	2.9	2.9	2.4
Detent Torque						
oz-in	4	8	10	8.8	18.0	27.0
(Nm)	(0.029)	(0.058)	(0.072)	(0.062)	(0.130)	(0.190)
Bearings Information						
Thrust Load						
lb	50	50	50	180	180	180
(kg)	(22.6)	(22.6)	(22.6)	(81.6)	(81.6)	(81.6)
Radial load						
lb	25	25	25	35	35	35
(kg)	(11.3)	(11.3)	(11.3)	(15.9)	(15.9)	(15.9)
End Play *(reversing load equal to 1 lb)*						
in	0.005	0.005	0.005	0.001	0.001	0.001
(mm)	(0.013)	(0.013)	(0.013)	(0.025)	(0.025)	(0.025)
Radial Play *(per 0.5 lb load)*						
in	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
(mm)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Motor Weight						
lb	3.8	5.1	8.3	3.2	5.3	7.6
(kg)	(1.7)	(2.3)	(0.34)	(1.45)	(2.41)	(3.45)
Certifications						
UL recognized	No	No	No	Yes	Yes	Yes
CE (LVD)	No	No	No	Yes	Yes	Yes

** Values shown in speed-torque curves at 75VDC

*** Small signal inductance values

Motor Dimensions

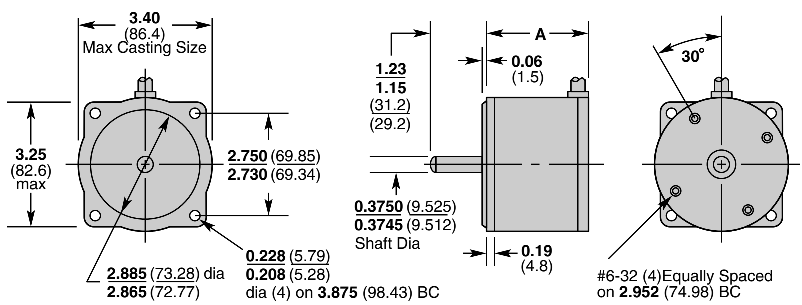


Dimensions in inches (millimeters)

Frame Size 23

Model		A
OS2HA	(OEM57-40)	**1.60** (40.7)
OS21A	(OEM57-51)	**2.06** (52.4)
OS22A	(OEM57-83)	**3.10** (78.8)

Size 23 Frame, OS Series and OEM57 Series Motors

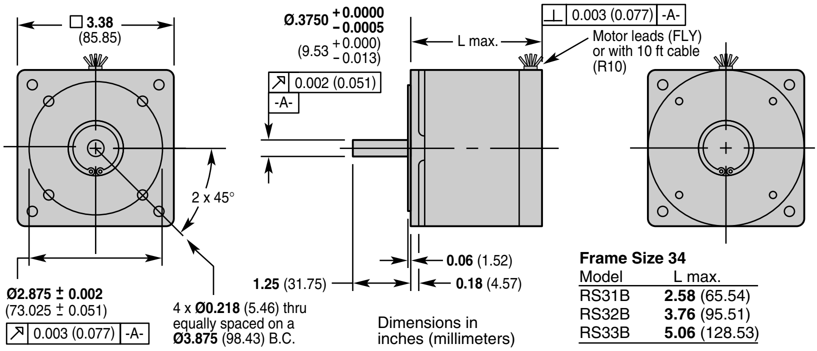


Dimensions in inches (millimeters)

Frame Size 34

Model	A
OEM83-62	**2.50** (63.5)
OEM83-93	**3.70** (94.0)
OEM83-135	**5.20** (132.1)

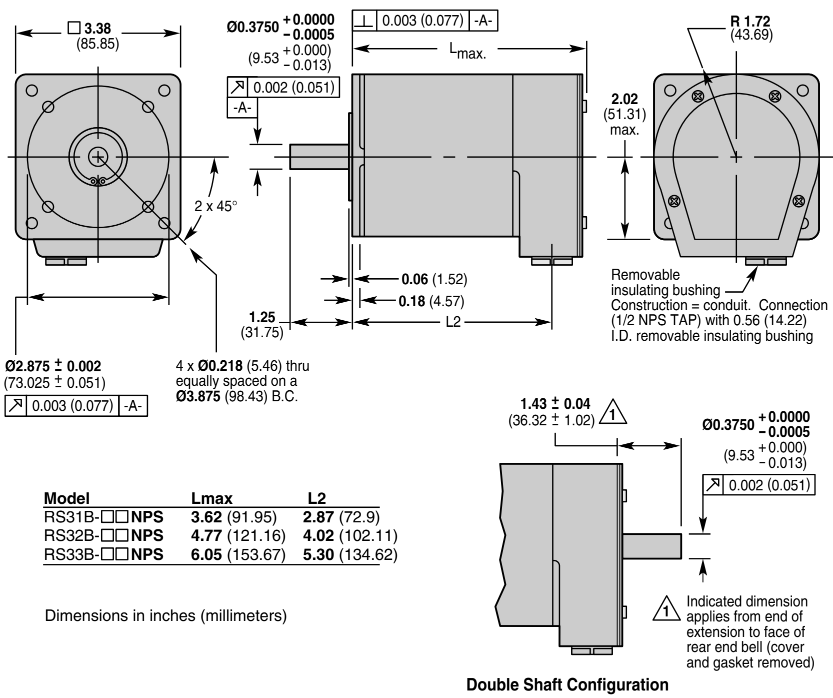
Size 34 Frame, OEM83 Series Motors



Frame Size 34

Model	L max.
RS31B	**2.58** (65.54)
RS32B	**3.76** (95.51)
RS33B	**5.06** (128.53)

Size 34 Frame, RS Series Motors, Regular Construction



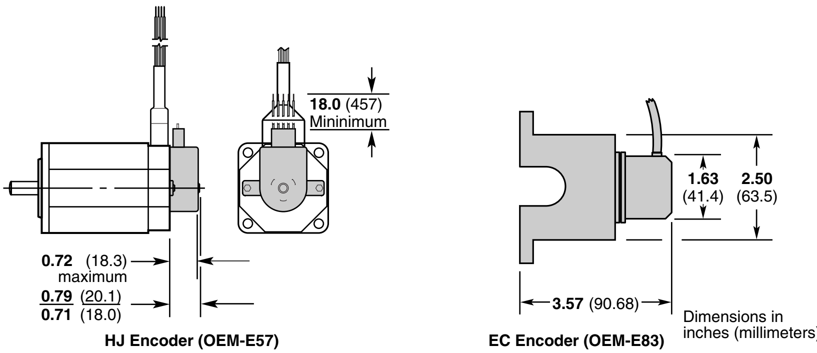
Model	Lmax	L2
RS31B-□□**NPS**	**3.62** (91.95)	**2.87** (72.9)
RS32B-□□**NPS**	**4.77** (121.16)	**4.02** (102.11)
RS33B-□□**NPS**	**6.05** (153.67)	**5.30** (134.62)

Dimensions in inches (millimeters)

Size 34 Frame, RS Series Motors, End Bell Construction (NPS)

Encoder Specifications

ENCODER DIMENSIONS



Dimensions – HJ (OEM-E57) and EC (OEM-E83) Encoders

ENCODER RESOLUTION

Model	Lines
HJ (OEM-E57)	512 Lines
EC (OEM-E83)	1000 Lines

ENCODER WIRES—COLOR CODE—HJ (OEM-E57)

Function	Wire Color	OEM750X D-Connector PIN Number
Channel A	White	17
Channel B	Brown	18
Channel Z	Blue	19
+5 volts	Red	
Ground	Black	7

ENCODER WIRES—COLOR CODE—EC (OEM-E83)

Function	Wire Color	OEM750X D-Connector PIN Number
Channel A+	Brown	17
Channel A–	Brown/White	Do not connect
Channel B+	Green	18
Channel B–	Green/White	Do not connect
Channel Z+	Orange	19
Channel Z–	Orange/White	Do not connect
+5 volts	Red	
Ground	Black	7
	Shield	Do not connect